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REPORT

REVIEW AND ANALYSIS OF VHF/UHF FIELD STRENGTH MEASUREMENTS:

Measurements at VHF over path lengths greater than 100 km

R.S. Sandell, C.Eng., F.I.E.E., C.P. Bell, B.Sc.(Eng.), and D.W. Taplin, A.M.I.E.E.

Research Department, Engineering Division
THE BRITISH BROADCASTING CORPORATION

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Summary

In 1983 CCIR IWP 5/5 put forward a number of proposals for improvements to the field strength prediction methods of CCIR Recommendation 370 and associated Report 239, as used for international planning negotiations in the VHF and UHF Broadcast Bands.

This Report describes the results of studies carried out by the BBC, in conjunction with other propagation investigations, to assess the validity of those proposals of IWP 5/5 which relate to propagation over path lengths in excess of about 100km in the VHF Bands.

It is concluded that these proposals can be supported with only one exception, relating to an addition of 7 dB to beyond-horizon oversea curves. Subsequently, the VHF proposals (excepting the one relating to the 7dB correction) have been endorsed by CCIR Study Group 5 and adopted by the Plenary Meeting in 1986 for inclusion as modifications to Recommendation 370. Even so, limitations in the existing methods are identified and further work is proposed.

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Section Title Page

Summary .... **Title Page**

1. **Introduction** **1**

2. **Important features of Recommendation 370 and Report 239 requiring clarification** **1**
   - 2.1. Measurement data **1**
   - 2.2. Correction factors **2**
   - 2.3. General comment **3**

3. **Scope of the BBC investigation** **3**
   - 3.1. Available measurements **3**
   - 3.2. Programme of work **3**

4. **Results** **4**
   - 4.1. Overland paths **4**
   - 4.2. Overseas paths **4**
   - 4.3. Mixed paths **6**
   - 4.4. Specific modifications proposed by IWP 5/5 and extent of incorporation in relevant CCIR texts **10**

5. **Future work relating to VHF bands and Recommendation 370** **12**

6. **Conclusions** **12**

7. **Reference** **12**

Appendix 1 .... **13**
Land paths Band I **12**
Land paths Band II **14**
Land paths Band III **15**
Mixed paths Bands I, II, and III **16**
Sea paths Bands I, II, and III **17**

Appendix 2 .... **18**
Proposals of CCIR Interim Working Party 5/5 .... **18**

Appendix 3 .... **20**
Calculated values of terrain irregularity (Δh) for certain broadcast stations in the U.K. **20**

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REVIEW AND ANALYSIS OF VHF/UHF FIELD STRENGTH MEASUREMENTS: MEASUREMENTS AT VHF OVER PATH LENGTHS GREATER THAN 100km

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1. INTRODUCTION

Since the mid-sixties the BBC has been using a field strength prediction computer program to assist with the planning of the UHF television services. This project has been successful, and very good accuracy has been achieved with this prediction technique at these frequencies. Over the past five years or so the same program has also been used for VHF work, but here the outcome has been less satisfactory. It is an improvement over the results obtained using the statistical propagation curves of CCIR Recommendation 370 and Report 239, but falls short of the accuracy achieved at UHF. It is suspected that at frequencies below about 150 MHz the influence of ground reflexion becomes significant. It is possible that a new technique could be devised which would take account of this effect, but it would be substantially more complex than the present method. Furthermore, very precise terrain data would need to be available. Such complexities do not rule out such a solution as the ultimate objective, but in view of the increasing interest in the development of VHF Band II (87.5–108 MHz) attention has been concentrated on improvement within the basic design of the present program. To this end the BBC is reviewing the results of past propagation experiments and field strength measurements obtained from many site tests and surveys.

The study involves a substantial programme of work and includes a review of the data upon which Recommendation 370 was originally based. Various doubts have been expressed about the adequacy of this Recommendation, and CCIR Interim Working Party 5/5 (IWP 5/5) was asked through Study Group 5 (S.G.5) to report upon the possibility of improvement before the Second Session of the recent Region 1 VHF/FM Conference. The IWP published an initial report (in early 1983) which provoked the BBC to offer some criticism. In order to offer constructive comments quickly the BBC has concentrated its initial propagation study on the VHF evidence for path lengths exceeding 100 km, with particular reference to the Recommendation 370 interpretation.

This Report describes the scope of the study, and the conclusions reached, the primary purpose being to provide data of immediate value to the work of IWP 5/5 on Recommendation 370. In this context, the parts of this paper which are directly relevant to the IWP study are Sub-section 3.2, describing the programme of work, Sub-section 4.4, which comments on the IWP proposals presented by them in 1983, and Section 6, which offers conclusions. Further results will emerge now that work towards the original objective, namely the improvement of the BBC's detailed prediction technique, has been resumed. Some of these results will still have direct relevance to the CCIR Recommendation 370 over its complete frequency range, and in due course it is intended:

(i) to carry out a corresponding study in the UHF Broadcast Band.
(ii) to assess whether there is sufficient evidence for differentiating between the various VHF broadcast bands in the CCIR prediction method.
(iii) to examine results for path lengths less than 100 km in both VHF and UHF Bands.

One further segment of this comprehensive study has already been completed[1] presenting the results of a review of VHF Band I field strength measurements and predictions. The measurements were obtained in the course of coverage surveys, and the study thus comes within category (iii) above. As such it is complementary to the work described in this Report, which is restricted to path lengths in excess of 100 km, and thus relevant to the interference aspects of network planning.

2. IMPORTANT FEATURES OF RECOMMENDATION 370 AND REPORT 239 REQUIRING CLARIFICATION

2.1. Measurement Data

When Recommendation 370 was originally drafted, at Geneva in 1963, it was based upon the technical data assembled for the Stockholm Conference of 1961, and at that time propagation research was concentrated on the development of television services, with particular emphasis on the UHF bands (470–960 MHz). Appendix 1 lists the VHF experiments for the long propagation paths (>100 km).

Since 1961 further measurements have become available from various sources, and some of these have been fed into the CCIR. Certain positive improvements can be identified, for example the introduction of curves describing propagation statistics for the Mediterranean Sea. In other respects ad hoc corrections which have been introduced to satisfy apparent inconsistencies have been less successful.

Apart from any inadequacies in the original data, there is a fundamental difference between the measurements made at short and at long ranges. The former were made in towns, and were the median values. They were therefore subject to urban clutter loss caused by surrounding buildings. Moreover, because most of the towns measured are situated in valleys, there is a further overall attenuation of the median caused by the local terrain. In contrast, results at longer ranges were obtained at open sites and corrected by a site variation factor (s.v.f.) which seldom involved measurements in towns. Urban clutter, therefore, did not figure in evidence above 100 km.

Discussion of location variation leads to the main criticism of Recommendation 370, namely inadequate definition of the two principal variables – time and location. In the case of time, part of the uncertainty again stems from the original measured data. The reception of distant transmitters over a period of time was analysed to show field strength values exceeded for stated percentages of time for each experiment. However, no distinction was made between the results of an experiment lasting three months, and one extending over two years. Some weighting would have been desirable, as would an attempt to define a 'worst month', but efforts to relate the results to meteorological data or tropospheric statistics were unsuccessful. The need for the latter was recognized at an early stage, indeed a proposal was made to measure lapse rates along various propagation paths over the North Sea, but practical problems could not be overcome and these attempts failed.

From the facts reported in the previous two paragraphs it will be appreciated that the original measurements were not reduced to a common datum in respect of time or location. In the case of the time variable, input data were normalised for a height of transmitting aerial above mean terrain of 300 m, for beyond-horizon distances. The field strength at a distance d_1 (km) from a transmitting aerial at a height h (m) was then considered to be identical with that from a transmitting aerial of 300 m at

$$d_2 = d_1 + (70 - 4.1\sqrt{h})\,\text{km} \qquad (1)$$

The families of curves in the Recommendation were derived from the h = 300 m curve in a similar fashion. However, the correction was not applied to the 1% time values over long sea-path curves at UHF because it was felt that transmitting aerial height changes would have little effect upon the ducting mode which causes these high values. The 5% time curves were interpolations between the 1% and 10% values and thus have about one-half of the height gain correction.

With regard to location distribution, the curves are stated to be representative of the conditions at average locations in rolling irregular terrain such as that found in much of North-West Europe and tipified by a Δh of 50 m. The parameter Δh is used to define the degree of terrain irregularity, and was originally introduced to reduce the scatter of UHF results at middle distances. Subsequently the correction was extended to the VHF band above 80 MHz.

Recommendation 370 gives information on the variation of field strength with location about the median value. At VHF a single curve with a standard deviation of 8 dB was given, it being assumed that the slope is not affected by terrain. At UHF the distribution is a function of Δh. In neither case is there any definition regarding the size of the area for which the distribution obtains. Furthermore, the emphasis is on the time median distributions. There is some evidence to suggest that the location distribution changes with varying propagation conditions.

2.2. Correction Factors

Certain correction factors given in Report 239–5 must also be noted.

Firstly there is the correction to data obtained at open coastal sites on over-sea propagation. The Report notes that corrections of the order of -7 dB should be applied to all measured results in the VHF and UHF bands made at open sites overlooking the sea so that the curves derived may be applicable for calculations of co-channel interference to coastal towns. Bearing in mind the way in which the original North Sea measurements were obtained (reported earlier), a further correction of -7 dB in addition to that for the site variation factor would appear to be inappropriate.

To give some detailed indication of the variation of field strength with location, the terrain clearance angle is described in Report 239. This method stems from one developed by the BBC in the early 1960s to deal with UHF only, although there are detailed differences from the method now published in the CCIR Report. This is a useful step towards obtaining a quantitative assessment of the effects of local obstacles, but further clarification of this technique is desirable, especially for VHF.

Mixed path correction at VHF is a simple interpolation based on the land and sea proportions. Ducting conditions leading to high signals over sea paths do not normally extend far inland; at UHF for low percentage times the propagation is weighted towards land path propagation. Clearer definition of mixed path behaviour is required.

2.3. General Comment

From the foregoing chronicle of criticism it would be easy to conclude that this Report finds little that is right with Recommendation 370 or Report 239. This is not so. For more than 20 years they have been extensively and successfully used for international planning and have withstood the test of time. However, this test of time has quite naturally revealed the limitations of these methods and subsequent interpretation of the original measurements, and the acquisition of greater knowledge during this time reveal the need for, and possibility of, improvement.

3. SCOPE OF THE BBC INVESTIGATION

3.1. Available Measurements

For purposes of description, the study now taking place is separated into two parts – short-range paths (<100 km) and long-range (>100 km) paths. Only the latter is dealt with in this Report.

In reviewing the available data for long-range paths, information from other UK sources as well as those of the BBC is being taken into account. Nearly all the data listed in a Department of Radio Technology (DRT) compilation by P.J. Brice in 1976 is being reviewed. A total of about 120 paths are involved, of which approximately 75% had been recorded by the end of 1960 and hence were included in the technical data for the Stockholm Conference. A breakdown of the duration of the individual experiments is as follows:

Less than six months:	10%
6–10 months:	26%
11–15 months:	34%
16–19 months:	15%
20–27 months:	15%

Of the 120 paths measured at VHF, approximately equal numbers were in each Band (I, II and III). In addition, a further ten paths were measured at frequencies in Band II by the DRT during 1981/82, and these are also detailed in Appendix 1.

Examination of the data revealed little evidence concerning propagation over sea paths in Band II for elevated transmitting sites. To provide further information on this and other aspects, a propagation experiment was stated in 1983 to record field strengths in England of transmissions from Ireland. Measurements have been made in the Morecambe Bay area of the Irish station at Kippure, and both Band II and III transmissions from this station were recorded. The results of this work will be the subject of a separate Report.

3.2. The Programme of Work

Proposals for modifications to Recommendation 370 and Report 239 were published by IWP 5/5 (Document 5/2) in February 1983. Their report observes that while the suggestions will offer an interim solution, the best approach would be to locate and re-appraise the early measurements. This is what is now being undertaken by the BBC, but it is clear that this appraisal will not be completed for some time. The maximum benefit will be obtained if the contribution from the BBC is related to the IWP proposals. Thus the work sequence is as follows:

(i) Finding and sorting original measurements in the VHF Bands.
(ii) Comparison of these results with predictions using Recommendation 370 with the modified curves proposed by IWP 5/5.
(iii) Continue with more detailed analysis of past results. The primary objective of this is to identify further improvements to Recommendation 370, including the feasibility of differentiating between VHF Bands I, II and III.
(iv) Widen the study to the UHF bands.
(v) Use the evidence produced from the study to improve the more detailed BBC prediction programs, and to examine the possibility of harmonizing this technique with the CCIR method.

The work involved in (i) and (ii) above has now been completed in respect of path lengths > 100 km.

4. RESULTS

As previously indicated, the review of the early measurements has to date concentrated on the long-distance paths listed in Appendix 1. They have been sub-divided into the three basic types of propagation path – overland, oversea, and mixed. Predictions have been prepared for each receiving site, using Recommendation 370, modified where appropriate as proposed by IWP 5/5.

4.1. Overland Paths

Predicted field strengths were derived from the field strength/distance curves of Rec. 370, values of Δh and heights above mean terrain being obtained using a terrain data bank. Although the latter is comparatively coarse (heights for the UK are stored for each unit of a 0.25 sq. km grid) errors due to this source for these parameters are insignificant.

Where available, measured or estimated site variation factors (s.v.f.) have been used to convert to the 50% location result. These were originally obtained by comparing field strengths at points within about 10 km of each fixed site with the value measured at the latter. They thus provide an indication of the field strength distribution within the area, and the relationship of the fixed site results to the average value. Measuring teams from the various organizations within the UK did not use standardised techniques for determining s.v.fs, and so some disparity between the results has been detected. For example, Post Office teams made more measurements around each fixed site than the BBC, but for shorter comparison periods. They also covered somewhat larger areas, and some of their measurements were made in towns, whereas all BBC results were obtained in open country. For these reasons the slope of the Post Office s.v.f. curve is greater than that of the BBC, with a standard deviation of 10 dB compared with 6 dB for the BBC. The curve of Fig. 5 of Recommendation 370 has a standard deviation of 8.3 dB, without referring to the limits of the area covered, or its nature. This is an important aspect which is discussed later. It is sufficient at this stage to assume that the field strength values under discussion represent the 50% location condition.

Fig. 1 shows the comparison of measured and predicted values for Bands I, II, and III as a function of distance. The distributions and standard deviations of these results are also tabulated in Table 1.

It will be seen that the disparity between measurement and prediction is greatest at Band II, in which prediction appears to underestimate the measurement, very significantly for small percentage times. At this point there is no certain explanation for this, although various theories are being explored. One possible reason lies in the choice of sites. In general these were good, open locations, where the fading ranges are likely to be greater than at average locations. In constructing the original VHF curves, the significant discrepancy of the Band II data was masked.

One interesting observation concerns the use of Δh for Band II prediction in North Western Europe. Fig. 2 shows that if this is omitted, or limited, then there is a marked improvement in accuracy compared with Fig. 1. Table 2 gives the distributions for these conditions.

4.2. Oversea Paths

The study discussed here relates solely to sea paths with one terminal in the UK. Following proposals of IWP 5/5, corrections for $\Delta h = 10\,\mathrm{m}$ have been applied to create new curves for 50% and 10% time conditions, and a 5% curve has been introduced by interpolation. This process produces the basic curves (for an effective height of 300 m) shown in Fig. 3 (for clarity the 10% curve is not shown). At distances of less than 170 km, for height above mean terrain of 300 m, the 10% time curves would exceed the unmodified 5% time values, and it is reasonable to change to interpolated values. On the basis of measured evidence there is good reason to adopt the interpolated 5% time curve throughout.

In Section 2.1.2 of CCIR Report 239-5, dealing with the construction of UHF curves, it recommends that corrections of – 7 dB should be applied to measured results at open coastal sites for beyond-horizon sea paths, both VHF and UHF. It is stated that the original data were depressed by this amount to take account of conditions in coastal towns, where values would be lower than those recorded at adjacent open sites with a clear view to the sea. Referring to Appendix 1, there is little evidence regarding Band II sea paths, in fact it is limited to the Post Office and five BBC experiments. However, it must be noted that the s.v.fs were about – 5 dB, i.e., this amount was deducted from the measurement to give a value representative of the *open country* in the coastal area. In this respect, therefore, the original bases used for long distance land and sea paths were identical. There is thus no reason to add 7 dB to the oversea curves, unless there is an intention to represent an exposed site, even more exposed than those used for the original experiments.

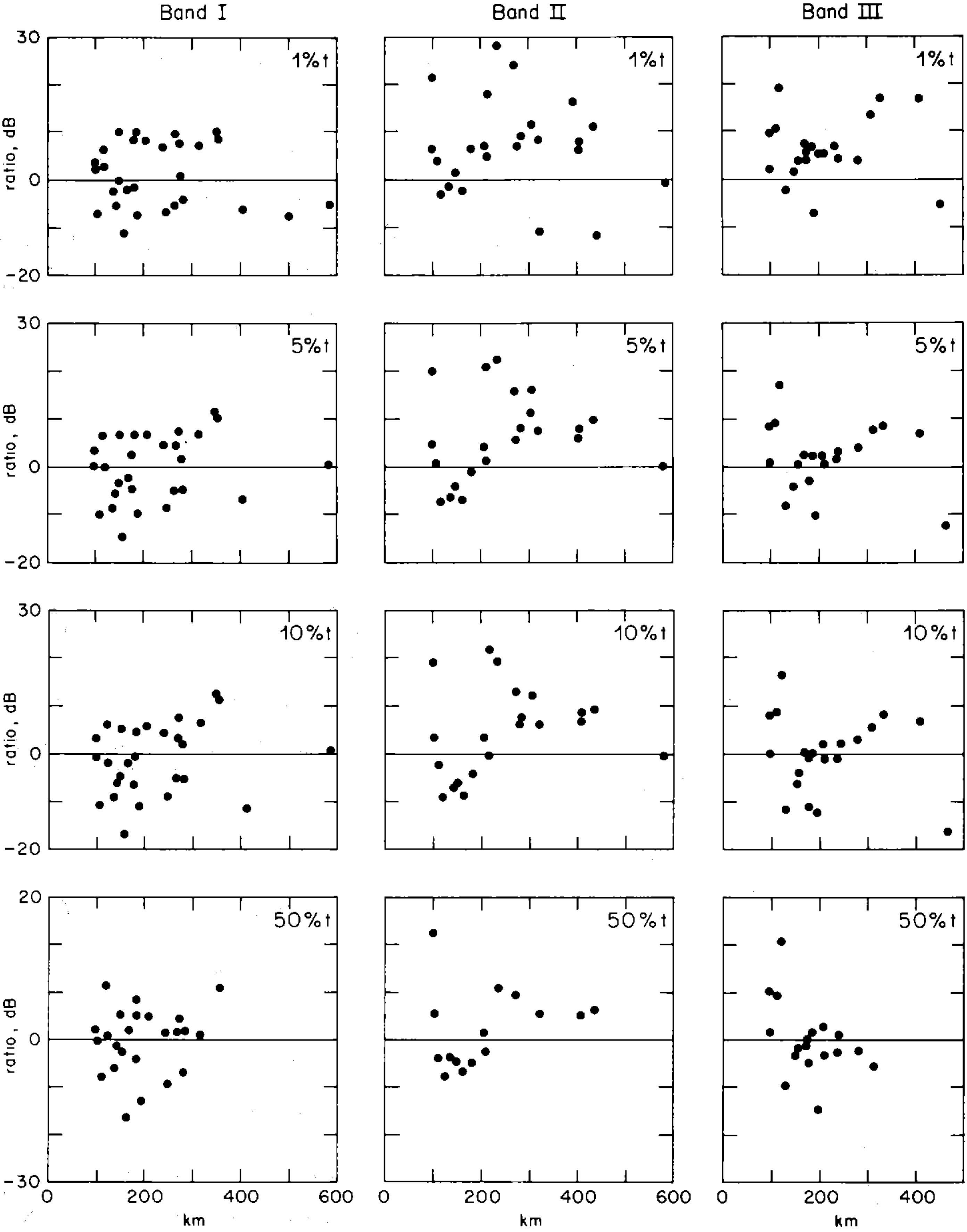

Fig. 1 – Comparisons between measurements and propagation predictions over land paths in broadcast frequency bands I, II, and III for specified time-percentages. The ordinate indicates the ratio (dB) of measured field strength (adjusted by site variation factor) to prediction based on CCIR Rec. 370-4. In this Fig. no Δh correction has been applied to the prediction.

Comparisons between Measurements and Predictions (based on Rec 370–4)*

Table 1: Overland Paths

	1% Time			5% Time			10% Time			50% Time		
Freq. Band	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)
I	29	+1.0	6.7	28	0	6.9	28	−1	7.4	24	0	6.9
II	24	+7.2	9.7	21	+5.9	8.9	21	+4.7	9.2	15	+2.2	8.4
III	21	+6.0	6.7	21	+2.0	6.9	21	0	8.0	20	−0.5	9.1
I II III	74	+5.0	8.6	70	+2.5	8.0	70	+1.5	8.5	59	0	8.1

* In Tables 1–4 the ratios specified are of Measurement : Prediction i.e. a positive value indicating the measured value to be higher than the prediction.

In constructing Fig. 4, the value of 7 dB has been used as the effective s.v.f., instead of the original figures of 5 to 6 dB, and the figure shows that the greatest discrepancies occur at Band III for short ranges. Table 3 reveals the error to be small for the VHF band as a whole, but again, the amount of information available is small.

The adoption of the derived 5% curve proposed by IWP 5/5 gives a smaller average difference than that obtained using Recommendation 370. The latter produced a figure of +9 dB for the ratio measurement to prediction, whereas the table shows the former to be +2.5 dB. There are, however, no 5% time measurements beyond 540 km, and the two at this distance suggest the IWP method may be overstating the field strengths at greater distances.

At this point it is pertinent to note some of the results now emerging from an oversea experiment established by the BBC in 1983. This is measuring field strengths in England from a transmitter in Ireland. One of the objectives of this experiment is to provide evidence regarding overseas propagation with high transmitting and receiving aerials – a situation contrasted to the conditions of the early experiments in which low terminal heights were used. Early results for VHF Band II are shown in Table 4.

These early results tend to support the expectation of height gain, although the true situation is somewhat obscured in this form of presentation. Analysis is continuing.

4.3. Mixed Paths

The classification of a mixed path is open to discussion. In general, the interpretation used in this study is as follows:

Land path:	More than 75% of total route overland.
Sea path:	One in which both terminals are within line of sight of the sea.

The current investigation has used the linear interpolation method A given in Report 239-5, viz.

$$E_{(\mathrm{mixed})} = \frac{E_{(\mathrm{land})} + \mathrm{d}_{(\mathrm{sea})}}{\mathrm{d(total)}} \times \left[E_{(\mathrm{sea})} - E_{(\mathrm{land})}\right] \quad (2)$$

where E is expressed in dB rel. 1 μV/m.

For the comparison shown in Table 5 the Δh correction factors have been applied to the land path calculations and the oversea calculations follow IWP 5/5 proposals. The measured results have been adjusted for the s.v.fs emerging from the experiment, as listed in Appendix 1. The present comparison shows the interpolation prediction method A to be reasonably accurate when applied to the mixed-path evidence. It must be noted that prior to 1981 there were Band II measurements available for only three paths, and these were for ranges exceeding 450 km. In 1981 measurements were made over 10 more paths, by the UK Home Office/DTI, but at this stage the results have not been examined in detail within this study.

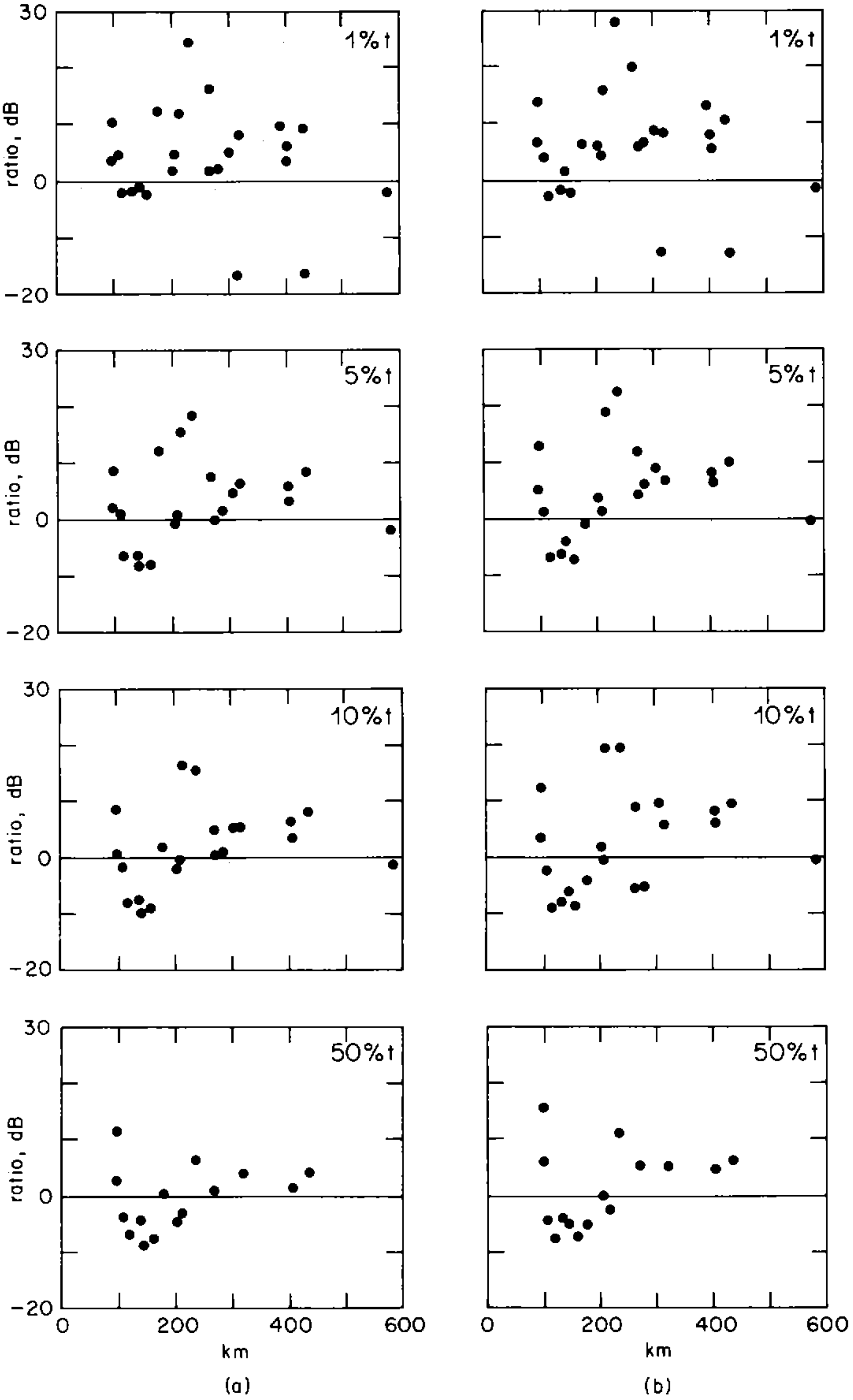

Fig. 2 – The effect of terrain irregularity correction (Δh) on land path predictions in Band II. The ordinate indicates the ratio (dB) of measured field strengths adjusted by site variation factor to predictions based on Rec. 370: a) without Δh corrections applied; b) with Δh corrections (limiting at Δh = 150 m).

Table 2: Overland Paths: Effect of Δh correction – Band II only

	1% Time			5% Time			10% Time			50% Time		
Δh	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)
Full	24	+7.2	9.7	21	+5.9	8.9	21	+4.7	9.2	15	+2.2	8.4
limited ≤150 m	24	+6.0	9.1	21	+5.0	7.9	21	+3.7	8.3	15	+1.4	7.1
none	24	+3.8	9.0	21	+3.1	6.9	21	+1.9	7.1	15	0	5.7

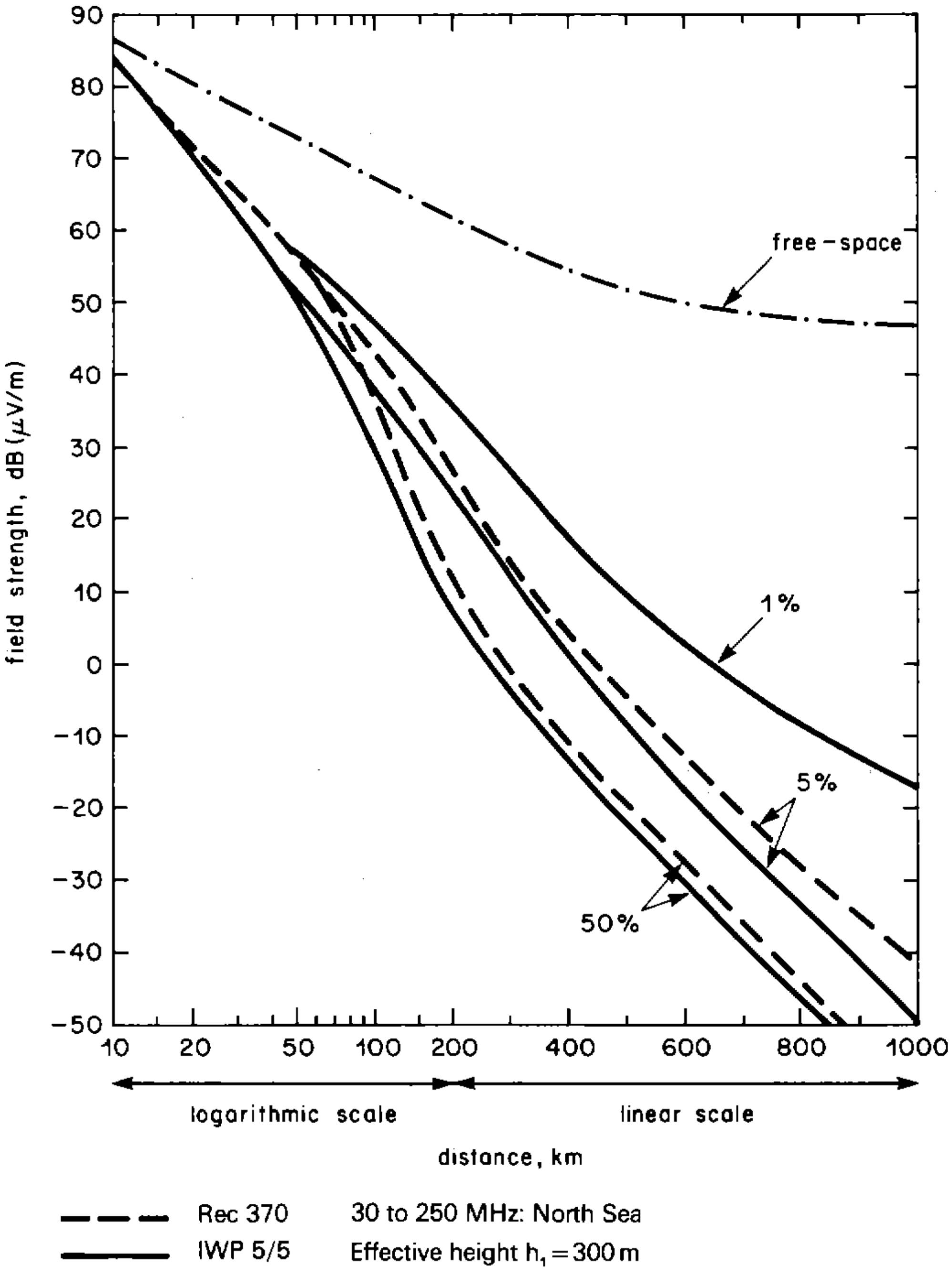

Fig. 3 – CCIR Prediction Curves for Cold Sea Propagation in frequency bands I, II, and III for specified time percentages.

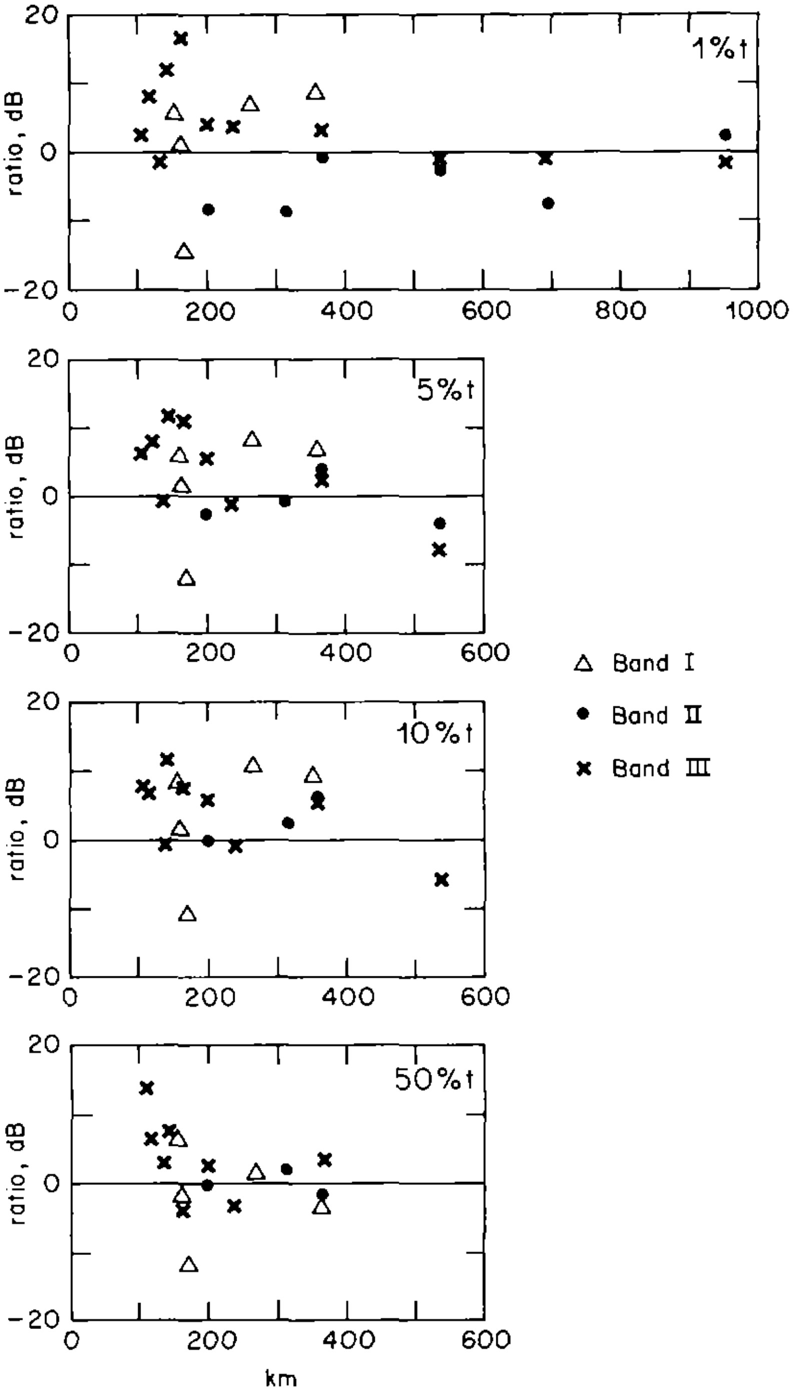

Fig. 4 – The ratio (M-P-7 dB) of measured field strength (M) less 7 dB to IWP 5/5 prediction (P), over sea paths for specified time percentages.

Table 3: Oversea Paths: Coastal Site Adjusted

	1% Time			5% Time			10% Time			50% Time		
Freq. Band	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)
I II III	22	+1.5	7.2	18	+2.5	6.5	17	+4.0	5.8	16	+1.5	5.8

N.B. 5% time value difference using Rec. 370 was +9 dB (deviation 13.2 dB).

Table 4: Preliminary Results of Band II Measurements across the Irish Sea.

Frequency (MHz)	Transmitter	Aerial Height (a.m.t.)*	Path Length (km	Receiver	Aerial Height (a.m.s.l.)**	Ratio (M–P)–7 dB 50% time
95.3	Kippure	545 m	227	Walney	30 m	−6 dB
			235	Dalton	110 m	+1.5 dB

* Above mean terrain.
** Above mean sea level.

Table 5: Mixed Land/Sea

	1% Time			5% Time			10% Time			50% Time		
Freq. Band	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No. of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)	No of Expts.	Mean Ratio (dB)	Stand. Dev. (dB)
I II III	24	−3.09	8.2	34	+0.4	7.9	34	+1.2	7.9	31	+0.8	7.0

N.B. 5% time – the oversea calculation based on Δh = 10 m for Band I, II and III and interpolated from 1% and 10% values.

4.4. Comparison with Specific Modifications proposed by IWP 5/5

It is appropriate to conclude by commenting on the CCIR IWP 5/5 proposals for modifications to Recommendation 370-4 and Report 239, and to indicate subsequent action within Study Group 5. These proposals are listed in Section 6 of the IWP Report (IWP 5/5 Doc. 5/2) attached here as Appendix 2. The item numbers referred to are those of Doc. 5/2.

4.4.1. Proposals for modification to the oversea path curves of Rec. 370 (Item 6.6.)

Proposals:

(a) Item 6.6.3: New 10% time curves for the Mediterranean Sea to be generated (for d < 200 km) by application of a correction for the existing curves corresponding to Δh = 10 m (subject to the corrected values not exceeding those for 1% time).

(b) Item 6.6.4: A similar modification to the 10% time curves for the North Sea, but without the distance limitation.

(c) Item 6.6.6: New 50% time curves for both the North Sea and Mediterranean to be generated in a similar manner (subject to not exceeding values, as modified, for 10% time).

(d) Items 6.6.7 and 6.6.8: New 5% time curves to be generated or both North Sea and Mediterranean (to be consistent with (b) and (a) above).

Comment: The results of the study contained in this Report (see Fig. 4) support the modifications proposed for propagation over the North Sea. We have no evidence to support an opinion concerning propagation over the Mediterranean Sea.

Action by CCIR S.G.5: The modified curves were endorsed by S.G.5 and subsequently adopted at the 1986 Plenary Meeting, with North Sea and Mediterranean referred to as Cold and Warm Sea respectively.

A later IWP 5/5 Report, provided as an input to the Second Session of the VHF/FM Conference (Geneva 1984), proposed separate propagation curves for the East Mediterranean, and the area between the Shatt-al-Arab and the Gulf of Oman.

These were adopted (with qualifications) by the Conference but not incorporated as revisions to Rec. 370.*

4.4.2. Application of terrain irregularity correction (Δh) (Items 6.3, 6.6.9 & 6.6.10).

Proposal: The Δh correction should not be applied to oversea paths and only with great caution to overland paths having Δh values greater than 150 m or less than 10 m.

Comment: Since the Δh correction (for 10 m) was used as an arbitrary basis for derivation of the new VHF oversea curves (other than for 1% time) it is clear that it should not be applied again to the same curves. The need for caution in applying large Δh corrections can also readily be supported.

Similarly it is logical that Δh corrections should not be applied if by so doing predicted field strengths for overland paths are made to exceed those for corresponding sea paths. However, it should be noted that, irrespective of statements in Rec. 370 and Report 239, a higher value than 50 m is appropriate for Δh in the UK as indicated in Appendix 3. It is therefore improbable that the lower limit constraint will have much general application in the UK or Europe (other than the Netherlands).

Fig. 2 and Table 2 of this Report indicate that (for the paths considered) there is a marked improvement in prediction accuracy if the Δh correction is not applied. This evidence enabled IWP 5/5 to confirm the justification of the earlier decision by the First Session of the Regional VHF/FM Conference (Geneva 1982) that Δh should not be taken into account in planning. This decision had the effect of substantially reducing the effort required by Administrations in providing full transmission characteristics of their requirements.

Action by CCIR S.G.5: The 1986 Plenary Meeting adopted an addition to the relevant Section of Report 239 indicating limitations to the applicability of the Δh correction, with special reference to values greater than 150 m.

4.4.3. Subdivision of the VHF band (Item 6.1)

Proposal: The present band 30 – 250 MHz should be subdivided, with separate parameters for the three Broadcast Bands I, II, and III.

Comment: In principle this seems a reasonable proposition in view of the large frequency range involved. Diffraction losses and the effects of ground reflections can be substantially different in Band I and Band III. Consideration of the feasibility of making such a separation must await completion of the study of measurements over path lengths less than 100 km. Nevertheless it may be noted that the results over the longer paths forming the subject of this Report provide little support to the proposal.

Action by S.G.5: None, so far. Results of further studies are awaited.

4.4.4. 'Ideal' – open country measurements (Item 6.2)

Proposal: The reference location should correspond to that of an 'open' site.

Comment: This can be supported only to the extent that the curves should represent a 50% location in open country, thus retaining the existing concept that the curves should represent median location values. The variation about this median in terms of ground undulation, environment, and size of area should be defined.

Action by S.G.5: None. This item is closely linked to progress on item 6.1.

4.4.5. Line-of-sight conditions. (Item 6.4)

Proposal: Ground reflections should be taken into account within line-of-sight.

Comment: Although ground reflections are of importance in Bands I and II it is questionable whether this could ever be taken into account other than on a purely statistical basis in a simple method such as that of Rec. 370. This aspect will be considered further in a subsequent Report dealing with measurements at distances < 100 km.

Action by S.G.5: None – as for item 6.2.

4.4.6. 'Beyond-horizon' values (Item 6.5)

Proposal: For both VHF and UHF over-sea paths, the curves should be raised by 7 dB† to compensate for an original correction made to refer them to values in coastal towns.

Comment: This cannot be supported, for the reason quoted in Section 2.2. The statement in the

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* But referred to in a new Section 3.6 of Report 239.

† This modification to be in addition to that already proposed in 4.4.1.

1966 version of Report 239, referred to in the IWP 5/5 report, is not considered to be entirely accurate.

Action by S.G.5: None.

5. FUTURE WORK RELATING TO VHF BANDS AND RECOMMENDATION 370

Sub-section 3.2 of this Report outlined the programme of work which is being undertaken on this project. Having now made comments on the structure of the main propagation curves of Recommendation 370, the intention is to proceed with item (iv) of the work sequence, namely a more detailed analysis of past results in respect particularly to path lengths < 100 km, relevant to coverage area predictions. Some of this work, relating to Band I, has already been completed and is referred to in Reference 1.

The main objective of the more detailed analysis is to provide fuller information regarding the variation of field strength, in both time and location. In Section 1 of this paper, weaknesses of the CCIR texts in these respects were noted, and it was pointed out that to a large extent the difficulties stemmed from inadequacies in the original measurement data.

Dealing firstly with time, it may be useful to compare propagation behaviour with basic meteorological data. Such records are available, and it is hoped that some correlation may exist between signal strengths, types of fading and weather patterns over North-Western Europe. This may provide a link with current propagation work, which can benefit from full information about tropospheric conditions.

With regard to location variation, a great deal of evidence exists, and some improvement can be foreseen. Receiving aerial height gain, clutter and terrain losses, standing wave effects and polarization are all being examined. They are closely related, and the problem will be to devise simple parameters which allow their effects to be quantified. Corresponding comparisons must also be carried out in respect of the UHF Bands.

In this work the essential requirement for simplicity in the CCIR documentation is being borne in mind. There is no doubt that greater complexity could lead to higher accuracy, and such evidence is also being used to improve computer prediction programs. Recommendation 370 is seen as an essentially simple but effective technique to be used for international frequency negotiation, with a more complex prediction program available for the estimation of service areas and short-range interference. The improved accuracy of the latter is facilitated by providing detailed terrain data and clutter information, but importantly the two methods must be complementary.

6. CONCLUSIONS

This Report concludes that the majority of the proposals for up-dating CCIR Rec. 370 and Report 239, contained in the 1983 IWP 5/5 Report should be endorsed. There is one important exception relating to the addition of 7 dB to beyond-horizon oversea curves.

Subsequently these revised propagation curves (for VHF only, and without the 7 dB correction mentioned above) have been endorsed by Study Group 5 and adopted by the 1986 CCIR Plenary Meeting for inclusion as modifications to Rec. 370.

It is acknowledged that even so, the curves still reflect the basic inconsistency – that at short ranges they are based on measurements in towns, while at longer ranges they are derived from open-country experiments. The implications of this inconsistency may be more readily quantified when the study is extended to examine paths of less than 100 km in length. In general the CCIR curves will be used to predict interference at long ranges, and forecast coverage at the shorter distances. There will thus be an inbuilt protection factor.

The real value of CCIR Rec. 370 lies in its use for international frequency planning, and it is considered that on the basis of the evidence so far assessed, it remains a reliable technique. Less ambiguous definitions concerning time and location variation are desirable, and it is hoped that future work will produce suggestions in this regard.

7. REFERENCE

1. SANDELL, R.S., LEE, R.W., MALCOLM-COE, J. 1986. Review of VHF Band I Field Strength Prediction. BBC Research Department Report No. BBC RD 1986/4.

APPENDIX 1

LAND PATHS – BAND I

DISTANCE km	FREQ. MHz	TRANSMISSION PATH		PERIOD OF EXPT.		ORGANIZATION	SITE CORRECTION FACTOR
		TRANSMITTER	RECEIVER	FROM	TO		
100	58.25	Sutton Coldfield	Mursley	Jun '61	Dec '62	BBC	−5
102	48.25	Holme Moss	Arncliffe	Nov '59	Apr '60	PO	(−2)
110	41.5	Crystal Palace	Banbury	Jan '65	Dec '65	PO	−6
120	58.25	Sutton Coldfield	Green Hailey	Oct '54	Aug '56	DSIR	(−2)
122	63.25	Peterborough	Caversham	Jun '61	Dec '62	BBC	+3.5
138	58.25	Sutton Coldfield	Caversham	Jun '61	Dec '62	BBC	−5
144	58.25	Sutton Coldfield	Castleton	Dec '49	Apr '51	PO	(−2)
151	58.25	Sutton Coldfield	Slough	May '52	Nov '53	DSIR	(−2)
152	53.25	Rowridge	Banbury	Dec '58	Nov '59	PO	+10
161	63.25	Wenvoe	Caversham	Jun '61	Dec '62	BBC	−15
169	48.25	Holme Moss	Banbury	Dec '58	Jun '59	PO	+15
179	41.5	Crystal Palace	East Harptree	Nov '64	Nov '65	PO	−13
180	63.25	Wenvoe	Mursley	Jun '61	Dec '62	BBC	+4
183	58.25	Sutton Coldfield	Kingswood	Nov '61	Feb '62	BBC	+3
				Aug '62	Sep '62		
191	58.25	Sutton Coldfield	Reigate	Nov '61	Feb '62	BBC	−3.5
203	41.5	Alexandra Palace	Castleton	Aug '47	Oct '50	PO	(−2)
243	48.25	Holme Moss	Slough	May '52	Nov '52	DSIR	(−2)
250	48.25	N. Hessary Tor	Banbury	May '60	Feb '61	PO	(−2)
267	45	Alexandra Palace	Leeds	Sep '46	Oct '48	BBC	(−2)
272	48.25	N. Hessary Tor	Mursley	Jun '61	Dec '62	BBC	−6
273	48.25	Holme Moss	Kingswood	Nov '61	Feb '62	BBC	−1
				Aug '62	Sep '62		
282	48.25	Holme Moss	Reigate	Nov '61	Feb '62	BBC	−2
282	41.5	Crystal Palace	Halwell	Jan '66	Sep '66	PO	−6
315	63.25	Pontop Pike	Banbury	Jan '64	Dec '65	PO	−3
352	58.25	Sutton Coldfield	Portreath	Jan '51	Oct '51	BBC	+2
353	58.25	Sutton Coldfield	Redruth	Nov '51	Mar '52	BBC	(−2)
412	58.25	Sutton Coldfield	Largoward	Jan '51	Mar '52	BBC	−6
502	58.25	Sutton Coldfield	Redmoss	Jan '51	Mar '52	BBC	(−2)
584	45	Alexandra Palace	Largoward	Sep '49	Mar '50	BBC	(−2)

Note: Unless indicated in parentheses, site correction factors have been measured in accordance with procedures in CCIR U.K. Study Group V Docs. V/16 and V/36 (1960–62). Values in parentheses are estimated from considerations of the nature of each receiving site and measured correction factors.

APPENDIX 1 *(continued)*

LAND PATHS – BAND II

DISTANCE km	FREQ. MHz	TRANSMISSION PATH		PERIOD OF EXPT.		ORGANIZATION	SITE CORRECTION FACTOR
		TRANSMITTER	RECEIVER	FROM	TO		
100	91.5	Moorside Edge	Wrexham	May '49	Mar '50	BBC	(−2)
100	88.3	Sutton Coldfield	Mursley	Jun '61	Dec '62	BBC	−10
108	90.9	Daventry	Teddington	Apr '48	Aug '49	DSIR	(−2)
121	90.1	Peterborough	Caversham	Jun '61	Dec '62	BBC	−2.5
138	88.3	Sutton Coldfield	Caversham	Jun '61	Dec '61	BBC	−8
147	88.5	Rowridge	Mursley	Jun '61	Dec '61	BBC	−10.5
161	89.1	Wenvoe	Caversham	Jun '61	Dec '62	BBC	−10.5
179	89.1	Wenvoe	Mursley	Jun '61	Dec '62	BBC	−0.5
207	91.5	Moorside Edge	Cambridge	May '49	Mar '50	BBC	0
211	93.8/91.4	Wrotham	Dorket Head	Jan '51	Sep '52	BBC	−6
216	91.5	Moorside Edge	Bagley Croft	Jun '47	Oct '47	BBC	(−2)
234	93.8	Wrotham	Castleton	Aug '50	Dec '50	PO	(−2)
272	88.1	N. Hessary Tor	Mursley	Jun' 61	Dec '62	BBC	−5
277	91.5	Moorside Edge	Great Bromley	May '49	Mar' 50	BBC	−0.5
284	91.5	Moorside Edge	Kingswood	May '49	Mar '50	BBC	−2
303	91.5	Moorside Edge	Bartley	Jun '47	Oct '47	BBC	−2
319	93.8/91.4	Wrotham	Pannal Ash	Apr '51	Sep '52	BBC	−3
322	91.5	Moorside Edge	Christchurch	May '49	Mar '50	BBC	(−2)
397	91.5	Moorside Edge	Start Point	Jun '47	Oct '47	BBC	(−2)
405	93.8/91.4	Wrotham	Redruth	Nov '51	Mar '52	BBC	(−2)
407	93.8/91.4	Wrotham	Portreath	Jan '51	Oct '51	BBC	+2
433	93.8/91.4	Wrotham	Heddon Laws	Apr '51	Sep '52	BBC	−3
442	91.5	Moorside Edge	Redruth	May '49	Mar '50	BBC	(−2)
568	93.8/91.4	Wrotham	Largoward	Jan '51	Sep '52	BBC	−6

APPENDIX 1 *(continued)*

LAND PATHS – BAND III

DISTANCE km	FREQ. MHz	TRANSMISSION PATH		PERIOD OF EXPT.		ORGANIZATION	SITE CORRECTION FACTOR
		TRANSMITTER	RECEIVER	FROM	TO		
99	201.25	Mendlesham	Peterborough	Mar '60	Mar '61	PO	– 1.5
100	180.4	Sutton Coldfield	Mursley	Nov '54	Oct '56	BBC	– 8
111	191.25	Croydon	Banbury	Oct '56	Mar '57	PO	(– 4)
120	180.4	Sutton Coldfield	Green Hailey	Oct '54	Aug '56	DSIR	(– 4)
130	186.25	Lichfield	Douai Abbey	Jul '58	Nov '59	DSIR	(– 4)
151	180.4	Sutton Coldfield	Slough	Jul '54	Oct '56	DSIR	(– 4)
157	196.25	St. Hilary	Banbury	May '60	Oct '60	PO	0
171	180.4	Pontop Pike	Ottringham	Jan '57	Feb '58	BBC	– 1
176	196.25	Emley Moor	Banbury	May '60	Oct '60	PO	– 5
178	191.25	Croydon	East Harptree	Oct '64	Dec '65	PO	– 24
183	180.4	Sutton Coldfield	Kingswood	Jul '54	Nov '56	BBC	+ 5.5
193	191.25	Winter Hill	Banbury	Oct '56	Mar '57	PO	– 4
206	196.25	Dover	Banbury	May '60	Oct '60	PO	0
210	180.4	Pontop Pike	Dorket Head	Jan '57	Feb '58	BBC	– 1.5
236	180.4	Sutton Coldfield	Beddingham	Oct '54	Nov '56	BBC	– 13.5
241	191.25	Winter Hill	Baldock	Apr '57	Mar '58	PO	– 7
281	191.25	Croydon	Halwell	Jan '66	Sep '66	PO	– 7
309	186.25	Burnhope	Banbury	Jan '64	Dec '64	PO	– 9.5
330	180.4	Pontop Pike	Mursley	Jan '57	Feb' 58	BBC	– 5
411	180.4	Pontop Pike	Kingswood	Jan '57	Feb '58	BBC	(+ 5.5)
465	180.4	Pontop Pike	Beddingham	Jan '57	Feb '58	BBC	(– 13.5)

APPENDIX 1 *(continued)*

MIXED PATHS: BANDS I, II AND III

DISTANCE km	FREQ. MHz	TRANSMISSION PATH		PERIOD OF EXPT.		ORGANIZATION	PROP. OF SEA	SITE CORRECTION FACTOR
		TRANSMITTER	RECEIVER	FROM	TO			
113	53.25	Blaen Plwyf	Holyhead	Jun '57	Feb '58	PO	0.86	(−5)
147	63.25	Orkney (Netherbutton)	Scousburgh	May '60	Jan '61	PO	0.83	(−5)
261	63.25	Pontop Pike	Murcar	Apr '60	Dec '60	PO	0.64	(−5)
267	41.25	Caen	Tolsford Hill	May '59	Oct '60	PO	0.78	−13
(348)	48.25	N. Hessary Tor	Cork	Jul '59	Jun '60	PO	(0.77)	−8.5
411	41.5	Alexandra Palace	Douglas (High)	Mar '51	Dec '51	PO	0.34	(−5)
500	41.5	Divis	Leswidden	Feb '59	Apr '60	PO	0.87	−8
448	93.8	Wrotham	Douglas (Low)	Jan '52	Dec '53	PO	0.3	(−5)
453	93.8	Wrotham	Douglas (High)	Jan '52	Dec '53	PO	0.3	(−5)
662	93.8	Wrotham	Redmoss	Jan '51	Sep '52	BBC	0.44	−6
182	98.6	Aalter	Southminster	Jul '81	Jun '82	DTI	0.75	−2
201	98.6	Aalter	Stowmarket	Jul '81	Jun '82	DTI	0.65	0
206	98.6	Aalter	Chelmsford	Jul '81	Jun '82	DTI	0.65	+3
216	98.6	Aalter	Wennington	Jul '81	Jun '82	DTI	0.48	+5
223	98.6	Aalter	Sidcup	Jul '81	Jun '82	DTI	0.41	+1
277	92.6	Lopik	Stowmarket	Jul '81	Jun '82	DTI	0.65	+1
292	92.6	Lopik	Southminster	Jul '81	Jun '82	DTI	0.77	−2
314	98.6	Lopik	Chelmsford	Jul '81	Jun '82	DTI	0.68	−3
377	92.6	Lopik	Wennington	Jul '81	Jun '82	DTI	0.67	+4
347	92.6	Lopik	Sidcup	Jul '81	Jun '82	DTI	0.73	−3
(116)	191.25	Durris	East Linton	Jun '62	Nov '62	IBA(?)	(0.55)	(−6)
197	174.1	Lille	Aldeburgh	Mar '58	Dec '58	PO	(0.69)	+14
(216)	(?)	Mendlesham	Bridlington	Jun '62	Nov '62	IBA	(0.45)	(−6)
219	191.25	Winter Hill	Ballywater	Apr '58	Jan '59	PO	0.75	−2
229	191.25	Winter Hill	Dundrum	Feb '58	Jan '59	PO	0.84	+11
234	191.25	Winter Hill	Newtonards	Feb '58	Jan '59	PO	0.69	+15
240	185.25	Lille	Kingswood	Nov '52	Jun '53	BBC	0.22	(−4)
265	174.1	Paris	Tolsford Hill	Jun '59	Apr '60	PO	0.38	−17
308	174.1	Lille	Douai Abbey	Dec '58	Nov '59	DSIR	0.17	(−4)
312	201.25	Chillerton Down	Leswidden	Feb '60	Sep '60	PO	0.64	−11
342	174.1	Lille	Banbury	Jun '55	Mar '58	PO	0.16	−6
(355)	196.25	St Hilary Down	Cork	Jul '59	Jun '60	PO	(0.77)	−8
438	174.1	Paris	Banbury	May '64	Dec '64	PO	0.25	−3
472	174.1	Lille	Stoke Fleming	Jun '58	May '59	PO	0.78	−5

Note: (1) Field strength values for 1% time for the Aalter and Lopik series of measurements are not available.
(2) Distances in parenthesis indicate that calculated path lengths differ from values quoted in source documentation.

APPENDIX 1 *(continued)*

SEA PATHS: BANDS I, II AND III

DISTANCE km	FREQ. MHz	TRANSMISSION PATH		PERIOD OF EXPT.		ORGANIZATION	SITE CORRECTION FACTOR
		TRANSMITTER	RECEIVER	FROM	TO		
161	58.25	Les Platons	Stoke Fleming	Dec '59	Jun '60	PO	−7
163	53.25	Rowridge	Stoke Fleming	Dec '58	Oct '59	PO	−15
174	53.25	Blaen Plwyf	Dublin	Jul '59	Jun '60	PO	+3
271	58.25	Les Platons	Leswidden	Mar '59	May '60	PO	−6
363	42.0	Bergen	Scousburgh	Nov '56	Sep '58	PO	(−5)
202	94.35	Scheveningen	Happisburgh	Jul '54	Sep '55	BBC	−6
316	86 or 95.5	Fishguard	Portpatrick	Oct '44	Sep '55	PO	(−5)
368	94.35	Scheveningen	Flamborough	Jul '54	Sep '55	BBC	(−5)
541	94.35	Scheveningen	Newton-by-Sea	Jul '54	Sep '55	BBC	(−5)
696	94.35	Scheveningen	Bridge of Don	Jul '54	Sep '55	BBC	(−5)
954	94.35	Scheveningen	Lerwick	Jul '54	Sep '55	BBC	(−5)
111	187	Sanday	Scousburgh	Nov '57	Oct '58	PO	(−8)
121	201.25	Chillerton Down	Alderney	Jun '60	Jun '61	IBA	(−5)
138	191.25	Stockland	Alderney	Nov '61	Apr '62	IBA	(−8)
145	168	Wideford Hill	Scousburgh	Jul '59	Oct '59	PO	(−8)
165	201.25	Chillerton Down	Stoke Fleming	Jun '59	Nov '60	PO	−5
202	187	Scheveningen	Happisburgh	Apr '57	Dec '58	BBC	−6
240	191.25	Winter Hill	Dublin	Jul '59	Jun '60	PO	0
368	187	Scheveningen	Flamborough	Apr '57	Dec '58	BBC	−6
541	187	Scheveningen	Newton-by-Sea	Apr '57	Dec '58	BBC	(−5)
696	187	Scheveningen	Bridge of Don	Apr '57	Dec '58	BBC	(−3)
954	187	Scheveningen	Lerwick	Apr '57	Dec '58	BBC	(−10)

APPENDIX 2
PROPOSALS OF CCIR INTERIM WORKING PARTY 5/5
Extract from IWP 5/5 Doc. 5/2, February 1983

6. Specific modifications proposed to Recommendation 370–4 and Report 239–5

6.1. Recommendation 370 originally bore the sub-title 'Broadcasting and mobile services'. Since the XIIIth Plenary Assembly (Geneva, 1974), however, owing to the publication of Report 567 which was supplemented in 1978 by Recommendation 529 relating to the land mobile services, this reference has been changed to 'Broadcasting services'. Moreover, the band 30–250 MHz, which covers more than three octaves, is too large to enable realistic account to be taken of the effect which the frequency has on the phenomena of reflection, refraction and scattering which occur in propagation. The VHF band should therefore be divided into three sub-bands, each incorporating one of the three VHF broadcasting bands (47–68 MHz, 87.5–108 MHz, 174–230 MHz), e.g. 30–70 MHz, 70–130 MHz, 130–250 MHz.

6.2. The basic curves should correspond to 'ideal', but not exceptional, reception conditions which are easy to define and lend themselves to measurements that are convenient to reproduce and compare, i.e. open-site measurements. In the other cases, the effect of the environment should be taken into account by means of specific correction factors corresponding to individual environments. These correction factors may also depend on the frequency.

6.3. Since the Δh parameter is without significance in oversea paths, oversea and overland propagation curves should be shown in separate figures.

It would be advisable to consider whether the time percentages of the curves might not be confined to such standard values as 50%, 10% or 5%, 1%.

6.4. In the case of paths where the transmitting and receiving points are in line of sight, the curves should be reviewed on the basis of calculations using a combination of direct and reflected waves.

6.5. For beyond-the-horizon distances, curves relating to sea paths should be given values corresponding to open receiving sites, under the principle set out in 6.2. above. Section 2.1.2. of Report 239–5 states that for the measurements to be applicable for the calculation of co-channel interference in coastal towns, where the field strength may be expected to be lower than at the open sites, they incorporate a correction of approximately 7 dB relative to the measured values. This applies to both VHF and UHF and, although version 239–5 of the Report refers only to Mediterranean area, Section 2 of version 239–1 (Oslo, 1966) shows that the same correction was applied in the case of the North Sea. Accordingly, the curves for beyond-the-horizon sea paths ought to be raised by 7 dB. For both sea and land paths, however, the best solution would be to locate both the data used to construct the original curves and more recent measurement data, and to group them by frequency band and type of terrain (land or sea). New measurement programmes might also be launched, provided the studies are not delayed. Caution should be exercised when deriving propagation curves for 1% of the time from measurement data.

6.6. In order to present VHF propagation curves which have a consistent interpretation (vis-a-vis Recommendation 370 and Report 239) with respect to Δh corrections and time percentages as well as to provide distinct curves for land paths and sea paths the following modifications are proposed to Recommendation 370–4:

6.6.1. The curves in Figs. 4a, 4b and 4c for land, North Sea, and Mediterranean Sea, respectively, for 1% of time, are to be kept in their present form.

6.6.2. The curves given in Fig. 2a apply only for land paths, 10% of time (i.e. Fig. 2a should be relabelled).

6.6.3. The curves (for Mediterranean Sea, 10% of time) in Fig. 2b are to be modified as follows:

(a) for distance <200 km the values given in Fig. 2a (for land, 10% of time, Δh = 50) are to be corrected for Δh = 10 m. The values so calculated are taken unless they exceed (for a given h_1 at a given distance) the corresponding values given in Fig. 4c (for 1% time); in this case the values of Fig. 4c are used.
(b) for distances >200 km no changes are to be made.

6.6.4. Curves for 10% of the time for the North Sea are to be generated by taking the values for land at 10% of time (Fig. 2a) and adding the relevant Δh correction for Δh = 10 m, at each distance. The values so calculated are taken unless they exceed (for a given h_1 at a given distance) the corresponding values given in Fig. 4b (for 1% time); in this case the values of Fig. 4b are used. This will be a new Figure.

6.6.5. The curves given in Fig. 1 apply only for land paths, 50% of time (i.e. Fig. 1 should be relabelled and becomes Fig. 1a).

6.6.6. Curves for 50% of the time, for the North Sea and Mediterranean Sea, are to be generated by taking the values for land at 50% of time (Fig. 1) and adding the relevant Δh correction for Δh = 10 m, at each distance. The values so calculated are taken unless they exceed (for a given h_1 at a given distance) the corresponding values as derived in point 4 and point 3 respectively; in this case the values derived for the corresponding 10% situation are to be used. These will be new Figures: see new Figs. 1b and 1c attached.

6.6.7. Figs 3a and 3b are to be replaced by the attached Figs. 3a and 3b.

6.6.8. In order to generate 5% land or sea curves the method suggested in Report 239 has been used, whereby a linear interpolation between the above described 10% and 1% curves is applied.

6.6.9. In any future application of the proposed new curves the following limits must be observed. If, for a given percentage of the time, a land path value derived from the relevant curves is to be corrected for Δh = 50 m, the resulting value may be used unless it exceeds the corresponding value (i.e., same percentage of time, same h_1, same distance) for a North Sea path; in this case the value of the North Sea path is to be used.

6.6.10. The following text is proposed for additon to Recommendation 370-4, as a continuation of 1.2. of Annex 1:

> 'For different values of Δh, corrections may be applied to values obtained from the curves, as given by Figs. 7 and 8. However, in cases where Δh exceeds a value of approximately 150 m, the application of Δh, together with its correction factors, should be made with extreme caution.'

6.6.11. The sentence in brackets of the first paragraph of 4.1., second sentence, of Report 239-5 should be amended to read:

'(see 1.2. of Annex I, of Recommendation 370-4)'.

APPENDIX 3

CALCULATED VALUES OF TERRAIN IRREGULARITY (Δh) FOR CERTAIN BROADCAST STATIONS IN THE UK

Calculated values of terrain irregularity (Δh) around certain broadcast stations situated in the less-rugged parts of the UK (Distributions based on radials at 10° intervals).

Transmitter	Δh exceeded on specified % of radials (m)		
	10%	50%	90%
Wrotham	125	75	48
Sutton Coldfield	140	87	47
Oxford	130	80	40
Tacolneston	50	35	27
Pontop Pike	270	130	65
Peterborough	112	35	5
Cambridge	100	47	7
Northampton	80	63	44
Belmont	90	45	19

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